TRANSLATION
from:

71 851

Process and apparatus for producing thin slabs

~~Description~~ Background of the Invention,
Field of the Invention

The invention relates to a process for producing thin slabs with a predetermined convexity of their broad faces in a continuous casting installation, in which an immersion nozzle protrudes into a mold followed by a strand guiding means, ~~and~~ The invention further relates to a corresponding apparatus for carrying out the process.

Discussion of the Prior Art

German reference ~~DE~~ 41 31 828 C2 discloses a liquid-cooled width-adjustable plate mold for the continuous casting of strands of steel in slab format, in particular for a thickness of the slabs below 100 mm, in ~~which~~ the plate mold, the form of the broad-face plates at the strand outlet end of the mold corresponds to the strand format to be produced, the broad-face plates being designed as a planar surface in the adjusting region of the narrow-face plates.

This document does not give any suggestion that the strand format to be produced is also to have a convexity after leaving the mold.

German reference

~~DE~~ 38 27 991 discloses an apparatus for continuously casting flat slabs, in particular a steel slab with a thickness below 80 mm, ~~in which~~ apparatus there is opposite the larger crowned cross section on the charging side a cross section on the strand outlet side of the mold which is smaller and identically crowned in the central

region, and at least one roller of at least one pair of rollers of the supporting and guiding means following the mold has a caliber adapted to the emerging crowned strand.

The mold form known from this document as well as the form of the supporting and guiding means following the mold are designed in such a way that the mold has in the edge region a form adapted to the strand format, in other words there are already in the mold parallel side wall regions, which continue in the supporting and guiding rollers of the strand guiding framework.

German reference

DE 44 03 0 45 discloses a continuous casting installation for guiding strands of which the broad-face plates are made concave and the concavity is constant from the upper edge of the mold to the outlet of the mold and beyond to the last roller of the strand guiding means. The concave form in this case advantageously runs from the beginning of one narrow-face plate to the beginning of the other, opposite narrow-face plate.

The concave form of the broad-face plates known from this document concerns a relatively complicated form, which is influenced substantially by the flexure of the roller and the wear at the time.

The strand shell in the middle mold-width region, and consequently in the region of the pouring gate is disadvantageously subjected to a constant bending deformation

as a consequence of the drawing-off movement until it leaves the region of the pouring gate.

In the documents cited, the graduation of the thickness-reduction steps with respect to the width profile of the strand is not clearly definable with respect to the strand thickness deformation with a liquid crater directly beneath the mold, the so-called cast rolling.

Summary of the Invention

The object of the invention is to provide by simple constructional means a continuous casting apparatus having a mold and strand guiding rollers which reduce the loading on the strand shell and minimize the risk of longitudinal cracks and break-outs.

~~The~~ invention achieves this object ~~by the defining features of the~~ process claim, claim 1, and the apparatus claim, claim ~~4~~. The subclaims show advantageous ~~developments of the invention.~~

According to the invention, the broad faces of the mold are largely made up of planar surface parts and the strand guiding rollers have a contour which is made up substantially of straight lines. Right from the inlet of the mold there is provided in the central region a planar surface, which is maintained in the strand guiding direction and, beyond the mouth of the mold, is taken over completely by the central parts of the guiding rollers.

On both sides of this planar central part there are likewise provided planar surfaces in the direction of the narrow faces. These planar surfaces are exactly maintained both in their form and in their inclination from the inlet of the mold up to the end of the strand guiding framework.

Between the planar central surface of the mold and the planar side surfaces arranged on both sides there are provided transitional pieces. The extent of these transitional pieces ends within the mold, with the result that the lower region corresponds to the strand format. In addition, this form allows simple introduction and delivery of the cold strand when starting up the continuous casting installation.

In an advantageous configuration, the central part is shaped with a planar surface in the charging region. The planar central parts of both broad faces of the slab run conically toward each other in the direction of the strand, until within the mold they are guided in parallel, forming a so-called crown, up to the mouth of the mold.

In a further advantageous configuration, the central parts are planar in their surface and disposed in parallel in the charging region and, outside the shadow region of the immersion nozzle in the strand guiding direction, are connected by a connecting part to the central part having the "crown" in the region of the mouth of the mold. The central parts have in this case a form of which the

contour lines are parallel to one another and of which the longitudinal extent is designed in the form of an S in the strand conveying direction. The mouth of this S-form respectively goes over tangentially into the neighboring surfaces.

The slab produced in a mold according to the invention has broad faces which are made up of three planar surfaces, the side surfaces being conically shaped and the central surface being shaped with an elevation in comparison with the edge region. This form of slab makes better centering of the slab possible, especially with the strand drawing-off speeds customary nowadays. Uncontrolled movement of the strand in the mold and so-called snaking in the strand guiding framework are avoided as a result.

The outer form of the strand shell of the slab thus produced remains absolutely constant, at least as far as the lowest point of the liquid crater. The only change which the slab undergoes takes place in the direction of its thickness, only the narrow faces being deformed.

The middle mold-width region, to be precise the region designed as a trough, remains unchanged in its planar form until solidifying right through and ensures the most favorable lubricating conditions in the mold. The mold form according to the invention has the effect that the casting powder wets the surface of the strand with an amount which

can be reliably predetermined in the region of the greatest susceptibility to longitudinal cracks. Thus, thanks to its planar form, the strand shell is not subjected to any bending stress favoring the occurrence of cracks close to the surface in this middle mold-width region.

The solidifying conditions of the strand shell are especially influenced in the region of the transitional parts and the connecting part by separate channelling of cooling media.

The following strand guiding framework has supporting and guiding rollers, which ensure reliable transporting of the slab still having a crater. According to the invention, various forms of roller are proposed, to be precise complete rollers or else split rollers.

In the case of the split rollers, use is made of simple cylindrical rollers which are adapted to one another according to the shaping of the central or side surfaces of the slab form predetermined by the mold.

Furthermore, it is proposed to divide the rollers in a ratio of 2/3 to 1/3, and to carry out this division alternately. In this case, the 2/3 roller has a contour corresponding to the assignment of the central part to the side part.

Depending on the slab width, in the case of smaller dimensions in particular, use may be made of complete

rollers, which have as their contour the negative form of the lower part of the mold.

An example of the invention is presented in the attached drawing, in which:

Figure 1 shows a continuous casting mold with a constant central part;

Figure 2 shows a continuous casting mold with constant side parts;

Figure 3 shows a section through the continuous casting apparatus;

Figure 4 shows a plan view of the continuous casting apparatus;

~~Figure~~ Figure 5a & 5b show 5 ~~shows~~, a section through the strand guiding framework.

Detailed Description of The Preferred Embodiments

Figures 1 and 2 perspectively show a mold with a following strand guiding framework.

The mold has in this case broad faces 21, between which narrow faces 22 are clamped. The broad faces have a central surface 23, which is shaped with a planar surface and is disposed from the inlet up to the mouth of the mold.

In the charging region up to a length a, calculated from the inlet of the mold, the central parts are arranged parallel with one other with respect to their contour line

and, overall, run conically toward one another in the strand conveying direction. In this region, the central parts 23 are connected to side parts 24 and 25 via transitional parts 26 and 27.

The transitional parts 26 and 27 are shaped in the form of wedges, the wedge tip 28 still within the mold being spaced apart from the mold inlet by the distance a.

At the narrow faces 22 there are provided adjusting elements 31, by which the narrow faces 22 clamped between the broad faces 21 are adjustable for changing the slab format.

Provided beneath the mold are supporting and guiding rollers 41. In the present example, split rollers 43-45, having a cylindrical form, are represented.

In Figure 1, the width of the central part 23 is denoted by b. In the present figure, the width b remains constant, beginning in the charging region of the mold and extending up to the mouth of the mold.

In the charging region, the side plates have a width f which, following the conical transitional part 26 or 27, widens to the width g and maintains this width constantly up to the mouth of the mold.

In Figure 2, in the charging region, the central plate has a width c which, following the wedge-shaped transitional parts 26, 27, widens to the width b in the strand casting direction up to the length a of the mold and,

from there, remains constant up to the mouth of the mold.

In the case of this configuration, the width f of the side plates 24 and 25 remains constant over the entire length L of the mold.

An immersion nozzle 11, which has a tubular part 12 and a spade-shaped rectangular part 14, protrudes into the mold. The mouth 13 of the said immersion nozzle reaches under the level of the melt Sp (dashed line).

Figure 3 shows a section aa through the broad faces 21 of the mold.

Represented in the left-hand part of Figure 3 ~~the figure~~ is the planar-surface central plate 23, which at the distance a goes over into a straight region, disposed parallel to the opposite central plate.

In the right-hand part of Figure 3 ~~the figure~~, a first portion of the central plate 23 has a planar surface and is disposed parallel to the center axis I. This parallel part is adjoined with a tangential transition by a connecting part 29, which has in section an S-shaped form and in turn goes over into the parallel part of the central plate 23 in the direction of the mouth.

In the inlet region, the spade-shaped part 14 of the immersion nozzle 11 protrudes into the mold, reaching under the level of the melt Sp.

Represented beneath the mold are the supporting and guiding rollers 41.

The dashed line represents the distance D_s between the side plates 24 and 25, and consequently also the narrow face of the slab.

Represented in Figure 4 is a plan view of a mold broad face, together with the immersion nozzle 11 with its tubular part 12 and its rectangular part 14 and also the mouth 13, which reaches under the level of the melt Sp.

Represented in the right-hand part of ~~the figure~~ Figure 4 is the side plate 24, which has a constant width g.

Represented in the left-hand part of ~~the figure~~ Figure 4 is the side plate 25, which has in the inlet region of the mold a width f which, conically following the conical transitional part, has from the wedge tip 28 a width g.

The central plate 23 has with regard to the left-hand side of the figure a constant width b.

With regard to the right-hand side, the central plate 23 has a width c which widens in a way corresponding to the conical transitional part 26 and has from the wedge tip 28 the constant width b.

Represented beneath the mold are various rollers 43, 44.

Directly following the mold there are represented in ~~the present figure~~ Figure 4 a total of three rollers 43, 44, which

respectively have a cylindrical form and are inclined toward one another in a way corresponding to the inclination of the sides and of the central surface of the slab produced.

The rollers, represented as ~~items 3 and 4 of~~ the ~~framework~~, comprise a 2/3 roller 46 and a cylindrical roller 44. The roller 46 has a cylindrical portion and a conical part adapted to the inclination of the side surfaces.

Represented as ~~items 5 and 6~~ are rollers of which the complete contour corresponds to the slab produced in the preceding mold, both in the central region and in the side regions.

~~Figure 5 shows~~ a section through the guiding framework and the slab still having a crater in this region. Represented in ~~the upper part of the illustration~~ is the situation with the opposite pairs of rollers in the central region 43 and in the side regions 44, 45. These rollers support the broad faces 51 of the shell box made up of the broad faces 51 and the narrow faces 52. The shell box thereby envelopes the melt S, which forms in this region the crater within the slab.

Represented in ~~the lower region~~ is the situation with a complete roller 42, which has a cylindrical central part and conically enlarging side regions.

Also represented is a 2/3 roller 46, which supports the greater part of the slab broad face 51 and is adjoined in

the right-hand part of the illustration by a cylindrical roller 44, which supports the narrow face region.

Figure 5b

The present ~~diagram~~ clearly shows the slab having a "crown", which slab can be guided exactly through the strand guiding framework by the forms of rollers proposed here.